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STRIGA LUTEA

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[Following is the translation of an article by R. A. Safra, Weed Specialist, published in the Russian-language periodical Zashchita Rasteniy ot Vrediteley i Bolezney (Protection of Plants from Pests and Diseases), No 7, 1964, pages 40--41. Translation performed by Sp/7 Charles T. Ostertag, Jr.]

In the world flora the figwort family is the richest in parasitic and semiparasitic species which affect the root system of other plants. In the Soviet Union the semiparasitic plants -- cow-wheat, eyebright, yellow rattle and toothwort -- are widely known, as well as the full parasites -- the broom rapes (the latter are set apart in a separate family in the flora of the USSR).

Regarded as belonging to Orobanchaceae are species of Striga which are not found in the USSR and which are very close to broom rape, but differ from them in their degree of parasitism and the specialization of the plants affected. The broom rapes are full parasites, harming dicotyledons (gourd family, pulse family, nightshade, sunflower family) and very rarely -- monocotyledons (Gramineae). The degree of parasitism in Striga varies from full parasites (Striga similar to broom rape), semiparasites (Striga lutea) up to facultative parasites (Striga similar to eyebright). The first ones, just as the broom rapes, affect dicotyledons, the remainder -- grasses (maize, sorgo, rice, sugar cane, millet) and many wild and weedy species.

The main world areal of Striga encompasses the tropical and subtropical countries of the Eastern hemisphere between 30° North and 30° South latitude (India, Pakistan, Burma, Indonesia, Cambodia, Thailand, tropical Africa, Saudi Arabia and Australia).

For a long time it was considered that Striga could not develop outside of the stated areal. However, beginning with 1951, from individual tenant farms in the states of North and South Carolina (USA) reports started to come in concerning a disease of corn which led to the complete death of the plants. In July of 1956, affected plants were sent for investigation to colleges in North Carolina. Neither bacteria, fungi, viruses, nematodes, nor mineral deficiency, which could

cause the disease, were detected. But the attention of an Indian student, who was taking part in the investigations, was attracted to underground stems among the roots of the corn which were similar to the roots of Striga, which affected the sugar cane in his native land. Soon it was confirmed -- the disease was caused by one of the most aggressive species of Striga -- Striga lutea (Striga lutea Dowr., synonym Striga asiatica Benth.).

The detection of Striga in the USA caused great alarm, why the value of the harvest of crops that are affected by it (corn, sorgo and sugar cane) is calculated at 5 billion dollars yearly. In connection with this, in 1957 the species was added to the list of federal quarantine items. At the same time an extensive program was set up for studying it. Three million dollars was set aside for the research. Initially the work was carried out by agricultural test stations in the states of North and South Carolina, and in 1959 a special laboratory was organized in Whiteville (North Carolina), and an experimental farm for testing herbicides in South Carolina. At the present time the results of some of the work have been published.

The extensive investigation, conducted over a period of five years (1956 -- 1961), shows that the weed has not gone beyond the limits of the two states, but the area affected by the weed has increased sharply and amounts to 45 thousand hectares [one hectare = 2.47 acres]. The number of farms where Striga has been detected has increased from 112 up to 9,866.

Striga multiplies by seeds (they are very small), and one plant may form up to 500 thousand seeds. The first phase of germination lasts for 5-20 days and a temperature of 26-32° and sufficient humidity are necessary for it to take place. The second phase (as a result of which the rootlet is formed) takes place in one or two days and only under the stimulating action of the radical secretions of the affected grassy crops. Such crops as soy, cotton plants, flax, and castor plants further the germination of Striga seeds, but subsequently the semiparasite does not develop on them. If the seed passes the first phase and the conditions are not right for carrying out the second phase, it dries up and may be preserved in the soil for a period of 20 years, up until favorable conditions set in.

There is great interest in determining the chemical composition of the stimulating substances and synthesizing artificial stimulators, which when introduced into the soil would induce the germination of Striga seeds and clean the soil of them. The investigations showed that there are very little stimulators in the plants affected by Striga. For example, in order to obtain 2 mg of the chemical stimulator which

is formed in corn, 20 thousand sprouts are required. Up until now the precise chemical composition of this substance has not been determined, but it is closest to the coumarin compounds (the molecular weight of the stimulator is 100, it is neutral, very unstable to alkalis and somewhat more stable to acids). Out of 300 growth stimulants tested, only 18 organic compounds have been established as stimulators. The highest activity was possessed by derivatives of coumarin: 6-methoxy, 7-hydroxycoumarin (skeleton), and 4-hydroxycourmarin.

After germination of the Striga seeds, which usually takes place in two weeks following the planting of the plant-host, the rootlets of the weed begin to come in contact with the roots of the affected plant. The sprouts of Striga thicken and take on a conical form. In the course of the next 8-24 hours, under the influence of the mechanical pressure of the rootlets and the enzymes which are given off, which soften and dissolve the tissues of the affected plant, the sprout moves forward, forms a sucker, and converts to a parasitic form of life. From the affected plant it adsorbs all the plastic substances and the mineral solution which are necessary for its development.

In the next 4-6 weeks Striga forms numerous underground stems and roots. Being deprived of root hairs, they cannot carry out the usual physiological functions. Their role is reduced to the formation of stabler ties with the affected plant. Already after 4-6 weeks the Striga sprouts form a green stem, with a height of 15-30 cm, and narrow, opposite leaves. After 2-3 more weeks, they blossom with bright red flowers and bear fruit. The entire cycle of development lasts from 90-120 days.

In regions where the mass germination of Striga takes place, the losses in the harvest of sorgo, corn, millet and rice reach 60-80%. The weed inflicts the greatest harm during the period of underground development. The first external sign of affection is the wilting of the plant (even under conditions of sufficient moisture), then a cessation of growth. Depending on the degree of affection and the conditions of development, the plant dies or exists in a strongly depressed condition.

Various provoking and trapping crops, sorts, and the actions of fertilizers and toxic chemicals have been studied in the struggle with Striga. Five years of testing have shown that the most effective provoking (harmful) crop is millet. After the appearance of Striga on the surface of the soil, the young plants are plowed over. This depletes the reserve of seeds for the weed. Of the "trapping" crops

(they stimulate the germination of Striga seeds, but are not affected by them), the pea merits attention. After 3-4 years of cultivating these crops, a considerable lowering is noted in the degree of weed infestation of the fields

Out of 200 sorts of corn tested, they all proved to be sensitive to Striga, and somewhat of a resistance was observed in sorts of sorgo and sugar cane.

As it was found out, the development of Striga is prevented by high doses of nitrogenous fertilizers (higher than 1120 kg/hectare), but this speaks negatively for the crops. Good results are obtained by the preseeding application of a nitrogen fertilizer (224/hectare) jointly with the herbicide 2, 3, 6-trichlorophenylacetic acid (phenac) in a dose of 2.2 kg/hectare. From this mixture Striga died throughout the entire period of vegetation and the crop harvest was normal.

Several hundred chemical substances were tested as herbicides in the struggle with the weed. Phenac, a compound of 2, 3, 6-trichlorobenzoic acid, 2,4D and 2,2-dichlorophenoxyacetamid, and also various mixtures of these herbicides were very effective for presowing, pregermination and postgermination application.

At the various foci of the weed, various fumigants were used for disinfecting the equipment and materials. Bromethol was most effective. However, dormant seeds of Striga are difficult to destroy even with this fumigant.

During the testing of a complex of agrotechnical and chemical substances, the best results were obtained from the use of provoking grassy crops in connection with treatment with 2,4-D (when it was necessary).

Together with the scientific investigations, in the USA an extensive program exists for combatting Striga, mainly at the expense of the Federal Government. For example, in 1959 special detachments, equipped with transportation means and herbicides, treated more than 100,000 hectares. Thirty-five tractors were used and 226 thousand liters of 2,4-D were used up. On six thousand farms weedy lands were released from crop rotation. Here they used special measures with the sowing of provoking crops (corn, sorgo and oats). Simultaneously the struggle with Striga was carried out on untreated lands. They used a combination of 2,4-D and dinitrobutylphenol.

Taking into consideration that Striga develops easily both in flat country as well as at a height of 1830 meters above sea level, under the conditions of the strong humidity of India and in the arid zones of Saudi Arabia with a yearly precipitation of 125-250 mm, it can be assumed that this dangerous parasitic weed can become natural even in the USSR, primarily in the regions of Central Asia and in the Transcaucasus.